Birzeit University

Department of Electrical & Computer Engineering

First Semester, 2023/2024

ENCS5343 Computer Vision

Assignment#2

Due Date January 5, 2024

1. Background

An image retrieval system is a technology that retrieves relevant images from a database based on user queries. There are two main types of image retrieval systems: text-based and content-based. Text-based systems use keywords or tags to index and search images. Content-based systems analyze the actual content of the image, to find similar images. It typically involves extracting features from images, such as color, texture, and shape, and indexing them for efficient retrieval. These systems employ techniques like color histograms, edge detection, and deep learning to analyze and compare images. Users input an image, and the system returns images with similar visual content. Image retrieval systems are used in a variety of applications, including:

- Stock photography: Helping users find the perfect image for their project
- E-commerce: Helping customers find the products they are looking for.
- Medical imaging: Helping doctors diagnose diseases.
- Law enforcement: Helping investigators identify suspects.
- Personal use: Helping people find photos of their friends and family.

2. Objectives:

Overall Objective: Develop a functional CBIR system using different color features and evaluate its performance.

Specific Objectives:

1. Implementation of CBIR System: Develop a Content-based Image Retrieval (CBIR) system incorporating color histogram and color moment features.
2. Feature Extraction Experimentation: Experiment with the effectiveness of color histogram and color moment in representing image content for retrieval.
3. Evaluate the CBIR system: Define evaluation metrics for assessing the performance of the system (e.g., precision, recall, F1 score), conduct experiments on a benchmark dataset of images, and analyze the effectiveness of different color features and compare their performance.
4. Documentation and Reporting: prepare a detailed report summarizing the system development process, experimentation results, and insights gained from the comparison of color features.

3. Tasks:

The assignment contains four main tasks defined as following:

Task 1: Build the CBIR system: Design and implement a system architecture for image retrieval using color features. Develop functionalities for loading images, extracting features, computing distances, and ranking results.

Task 2: Implement the CBIR system using Color Histogram as an image representation. Experiment with 120 pins, 180 pins and with 360 pins. Use Euclidean as distant measure and compute precision, recall, F1 score, and time for each experiment. Construct a Receiver Operating Characteristic (ROC) curve by varying the retrieval threshold. Calculate the Area Under the Curve (AUC) to measure the overall performance across different threshold settings. Note that you need to compute these measures as an average of at least 10 different quires.

Task 3: in this task you need to experiment with color moments as following:

3.1: Implement the CBIR system using Color Moments (mean, standard deviation, and skewness) as an image representation. Use Euclidean as distant measure and assign equal weights to each moment. Compute precision, recall, F1 score, and time. Calculate the Area Under the Curve (AUC) to measure the overall performance across different threshold settings. Note that you need to compute these measures as an average of at least 10 different quires.

3.2: Same as task **3.1** but with different weights. You need to give a weigh relative to the important of the moment.

3.3: Same as task **3.2** but with the addition of more Moments including Median, Mode, and Kurtosis.

Task 4: Try to improve the performance of the CBIR system using other image representation techniques.

4. Data set

You can experiment with one of the following data sets:

- Wang database: A classic dataset containing 1,000 images from 10 different categories. Simple and widely used for evaluating basic CBIR algorithms.
- https://www.kaggle.com/datasets/theaayushbajaj/cbir-dataset
- Others

5. Report

Write a comprehensive report that include the following:

1. **Introduction**
   - Briefly introduce the concept of Content-Based Image Retrieval (CBIR).
   - Describe the theoretical background of color histograms and color moments.

2. **System Implementation**
    - Describe the overall architecture of the CBIR system. Explain the functionality of each module and their interaction.
    - Discuss the implementation details of the system, including programming languages, libraries, and frameworks used.
3. **Experimental Setup and results**
    - Describe the evaluation methodology, including the datasets used, evaluation metrics, and experimental setup.
    - Present the results of the evaluation, including precision, recall, F1-score, and other relevant metrics.
    - Analyze the effectiveness of different color features in terms of retrieval accuracy and efficiency.
    - Discuss the limitations of the current system and potential improvements for future work.
4. **Conclusion**
    - Summarize the key findings and achievements of the project.
    - Discuss the overall effectiveness of color features for CBIR tasks.
    - Provide insights and recommendations for further research and development in CBIR.